

# The Influence of Kidney Stones and Salivary Uric Acid on Dental Calculus Formation and Periodontal Status among Some Saudi Patients Aged 25 - 70 Years

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## Abstract

**Background:** The formation of kidney stones is considered a complicated process. Consequently, there are many questions about the link between kidney stones formation and level of salivary uric acid and calculus formation on the teeth surfaces. **Objectives:** To evaluate the correlation between the level of salivary uric acid and kidney stones formation and their influence on dental calculus and periodontal status among Saudi patients aged 25 - 70 years. **Materials and Methods:** 120 Saudi male patients were examined (60 of Kidney stones patients and 60 patients of non-kidney stones patients) for clinical evaluation of plaque index (PLI), gingival index (GI), calculus index of oral hygiene (CI) and clinical attachment loss (CAL). Moreover, lab assessment of uric acid level in the collected salivary samples was done. The findings were analyzed using of ANOVA test and Tukey's test. **Results:** There were statistically significant differences in clinical parameters among kidney stones patients and non-kidney stones patients ( $p < 0.05$ ), but these differences were highly statistically significant in the correlation between calculus index (CI), plaque index (PLI) and gingival index (GI) among kidney stone patients in group II, moreover, PLI and clinical attachment loss (CAL) among kidney stone patients in group III ( $p < 0.001$ ). The statistical analyses revealed statistically significant differences in the level of salivary uric acid (mg/dl) in the comparison between kidney stones patients and non-kidney stones patients in group I and group III, whereas there were highly statistically significant in the comparison between kidney stones patients and non-kidney stones patients in group III. **Conclusion:** At the end of this study, we concluded that

there was a relationship between dental calculus formation, kidney stones formation, and an increase in the level of salivary uric acid.

## Keywords

Dental Calculus, Kidney Stones, Uric Acid, Periodontal Status

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## 1. Introduction

The oral cavity is a part of the body that includes various microorganisms, which subsist as a normal community of complex biofilms, structurally organized and multispecies [1] [2]. Therefore, it may be an effective method for the assessment of general and oral health [3].

On the other hand, Saliva is the main liquid in the oral cavity and is essential to keep the oral tissues in healthy status by inhibiting proliferation specific microorganisms, and moreover, inhibiting the build-up of dental plaque and dental calculus [4]. Consequently, saliva may be considered a mirror that can reflect the normal and abnormal states of the body [3].

The anti-oxidative system in saliva includes different enzymes and molecules which are periodontal biomarkers in the evaluation of the periodontal status [5] [6]. Uric acid participates in the antioxidant ability of saliva and blood. Further, it forms nearly 70% - 85% of this ability in the saliva of healthy and periodontitis patients [7] [8] [9]. According to previous studies, there was a possible effect of uric acid and other antioxidants in periodontal disease initiation and progression in addition to uric acid association with some systemic abnormality such as kidney stones formation [10] [11].

A kidney stone is one of the most prevalent systemic diseases of current communities and infects 12% - 15% of the population, and calcium oxalate stones are considered the dominant type of kidney stones worldwide [12] [13] [14]. The possibility of kidney stones recurrence is approximately 10% - 50% through 1 - 5 years from the first infects of kidney stones [15]. In Saudi Arabia, the dehydration and hot weather are reflecting on the estimation of kidney stone risk on the life where the kidney stone incident is at least 50% more than the western countries and, up to 90% of these patients exhibit abnormal oral changes [16] [17].

Dental calculus is the mineralization of dental plaque on the natural tooth surfaces and dental prosthesis in the mouth. Moreover, it has the same biological system of the structure formation process of kidney stones and according to the place of calculus, there are supra and subgingival calculus that are covered by unmineralized dental plaque which is the main etiologic factor of periodontal diseases [18] [19] [20] due to the sharing of kidney stones and dental calculus in the process of calcification and formation factors. Also, there was no prior Saudi study found carrying out among patients from Aseer region to evaluate the influence of kidney stones and salivary uric acid on dental calculus formation and

periodontal status among some Saudi patients aged 25 - 70 years. Therefore, the present study was designed for the assessment of these objectives [21].

## **2. Materials and Methods**

### **2.1. Ethical Clearance**

The current retrospective study carried out at the outpatients' clinics, college of dentistry, King Khalid University between March 2020 G and August 2020 G. The research proposal was approved by the scientific research committee, college of dentistry, King Khalid University. The objectives of the study were fully exhibited to the patients at the beginning of this study, and the patients' informed consent was obtained to fulfill ethical clearance (IRB/KKUCOD/ETH/2019-20/039). The sample size of the study was identified according to the number of patients who come to the outpatients' clinics, the college of dentistry, King Khalid University through the study duration. The G\*Power software program was used for performing the sample size calculation [22].

The patients' data related to the patient name, age, gender, and general health were collected from the medical files of the patients. Furthermore, we asked the patients about oral hygiene measures, bad oral habits, and the presence or absence of xerostomia.

### **2.2. Participant Selection**

According to the proposal of this study, a total of 120 Saudi males patients interviewed 60 patients (study group) diagnosed as kidney stones patients based on radiographs and general urine investigations, and 60 patients were diagnosed without kidney stones based on ultrasound in the latter three months (control group). All patients were examined clinically to evaluate the amount of dental calculus and periodontal status; moreover, the salivary uric acid level was measured. The patients were divided according to the ages into three equal groups (n = 40): (Group I) 25 - 40 years, (Group II) 41 - 55 years, and (Group III) 56 - 70 years. All groups included two equal subgroups (n = 20). The subgroups comprised 20 kidney stones patients as study subgroups and 20 healthy patients (non-kidney stones) as the control subgroup.

### **2.3. Inclusion and Exclusion Criteria**

The patients of the study group were without other systemic diseases and, the size of the kidney stone was 20 mm. They were using tooth brushing but did not visit the dental clinics for calculus removal since one year ago. They did not wear orthodontic appliances or fixed or removable dental prostheses. Moreover, they were in a fasting status, whereas the patients of the control group were of good medical status.

The exclusion criteria were the patients who received periodontal therapy within the past 6 months, the patients with bone disease, endocrine disease, blood diseases, medically compromised patients, alcoholic patients, the patients with vitamin D deficiency, and who need calcium supplements. The comprehensive

kidney function evaluation was obtained from patients' medical reports that were within the patients' files to exclude any patients with other kidney diseases.

#### 2.4. Clinical Examination

Periodontal examination was done by the assessment of plaque index (PLI) [23], gingival index (GI) [24], calculus index of oral hygiene index (CI) [25] and, clinical attachment loss (CAL). All clinical parameters were recorded by a Williams probe with a diameter of 0.5 mm (Hu-FriedyIns Co., USA) of each tooth except third molar teeth. PLI, GI, and CI were assessed on mesio-buccal, buccal, dis-to-buccal, and lingual or palatal, whereas CAL was assessed in interdental areas according to the last classification of periodontal diseases [26] [27] [28]. PLI was recorded before the collection of saliva samples. The clinical findings were recorded in particular case sheets and charts.

#### 2.5. Salivary Collection of Saliva and Biochemical Investigations

The samples of un-stimulated saliva were obtained in the morning after breakfast (9-11 am) to reduce circadian changes. The patients were demanded to swallow of saliva and stay stable 10 min for collection of saliva into a sterilized plastic. The samples were transported on dry ice within less than 30 min for lab investigation after stored at  $-70^{\circ}\text{C}$ . The experiment of saliva collection was conducted by the Modified Navazesh method [29]. A centrifuge was used at 4000 g for 10 minutes at room temperature to remove cell debris, and an Erba kit was applied as an enzymatic method to identify uric acid.

#### 2.6. Statistical Analysis

Statistical analyses of this study were done by ANOVA test for an account and, demonstrate the mean and standard deviation of the clinical results, and biochemical investigations findings. The scale of significance was assessed by using Tukey's test, and it was acceptable at  $P < 0.05$ , and highly significant when  $P < 0.01$ .

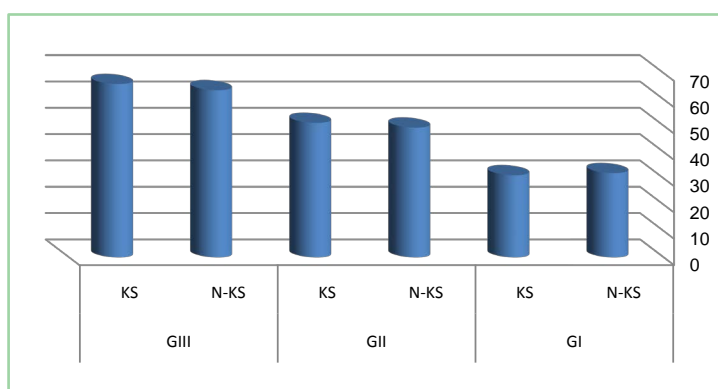
### 3. Results

The present study included a total of 120 male Saudi patients (50% kidney stones patients and 50% non-kidney stones patients) into three different age groups. The distribution of patients as kidney stones patients or non-kidney stones patients within the study groups as subgroups, which appears in **Table 1** and **Figure 1**. **Table 1** and **Figure 1** illustrate the age distribution and the mean of age among study groups. The mean age for non-kidney stones patients was 32.01 ys and 31.22 ys for kidney stones patients in group I. Moreover, it was 49.3 ys for non-kidney stones patients and 51.1 ys for kidney stones patients in group II, whereas it was 63.51 ys for non-kidney stones patients and 65.87 ys for kidney stones patients in group III. There were statistically significant differences in the ages between groups I, II, and III ( $p < 0.05$ ) but, there were no statistically significant differences in the age between non-kidney stones patients and kidney stones patients in this study ( $p > 0.05$ ).

**Table 1.** Age distribution and the mean of age among study groups.

Groups	Range	No	Mean $\pm$ SD	ANOVA		Tukey's test			
				F	P-value	I&II	I&III	II&III	
<b>G I</b>	25 - 40 ys	40	N-KS	32.01 $\pm$ 8.11	4.322	0.031	0.021	0.013	0.040
			KS	31.22 $\pm$ 4					
<b>G II</b>	41 - 55 ys	40	N-KS	49.3 $\pm$ 2.46					
			KS	51.1 $\pm$ 4.21					
<b>G III</b>	56 - 70 ys	40	N-KS	63.51 $\pm$ 6.32					
			KS	65.87 $\pm$ 9.71					
N-KS	25 - 70 ys	60	48.27 $\pm$ 5.63	1.712	0.186		0.563		
KS	25 - 70 ys	60	49.39 $\pm$ 5.97						

G: group, No: Number of participants, SD: Standard deviation, N-KS: non-Kidney stones, KS: Kidney stones.



**Figure 1.** The mean of age among the study groups. G: group, N-KS: non-Kidney stones, KS: Kidney stones.

When we asked the patients about the self-plaque control, the feeling of dry mouth, and bad oral habits, just 45% of kidney stones patients reported that they used a toothbrush in self plaque control compared to 55% of non-kidney stones patients. Moreover, 87% of kidney stones patients were feeling of dry mouth and 13% of non-kidney stones patients clarified that there were no feeling of dry mouth. Opposite we detected in the patients' answers that 78% of patients were smokers (50% kidney stones patients and 50% non-kidney stones patients).

Regarding the comparison of groups I, II and, II in clinical parameter values. There were statistically significant differences in PLI and CI among the kidney stone patients plus GI and CI among non-kidney stones patients ( $p < 0.05$ ), whereas there were no statistically significant differences in GI and CAL among the kidney stones patients moreover PLI and CAL among non-kidney stones patients ( $p > 0.05$ ) (Table 2 and Figure 2).

On the other hand, there were statistically significant differences in PLI, GI, CI and CAL in the comparison between group I, II the kidney stones patients ( $p < 0.05$ ) vice versa in non-kidney stones patients where there were no statistically

significant differences in PLI, GI, CI, and CAL ( $p > 0.05$ ) and also there were statistically significant differences between group I and III in PLI, GI, CI, and CAL among kidney stones patients moreover, PLI and GI among non-kidney stones patients ( $p < 0.05$ ), whereas we did not find statistically significant differences in CI and CAL among non-kidney stones patients ( $p > 0.05$ ). Furthermore, there were no statistically significant differences between group II and III in all clinical parameters except CI among non-kidney stones patients ( $p > 0.05$ ).

In this study, the correlation between clinical parameters with CI of all patients was analyzed by ANOVA test (Table 3). Significant statistically significant differences between clinical parameters and CI were observed among kidney stones patients and non-kidney stones patients ( $p < 0.05$ ), but these differences were highly statistically significant in the correlation between CI and PLI and GI among kidney stones patients in group II moreover, PLI and CAL among kidney stones patients in group III ( $p < 0.001$ ).

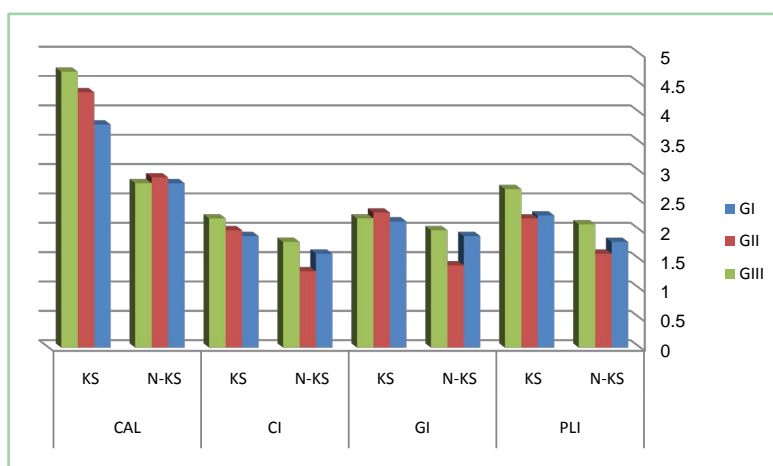


Figure 2. Clinical findings. PLI: Plaque index, GI: Gingival index, CI: Calculus index, CAL: Clinical attachment loss.

Table 2. Clinical findings.

CP		Groups			ANOVA		Tukey's test		
		GI	GII	GIII	F	P-value	I&II	I&III	II&III
PLI	N-KS	1.8 ± 0.2	1.6 ± 0,6	2.1 ± 0.4	2.322	0.115	0.112	0.001	0.279
	KS	2.25 ± 1.2	2.2 ± 0.7	2.7 ± 1.1	1.499	0.044	0.011	0.002	0.232
GI	N-KS	1.9 ± 0.6	1.4 ± 0.5	2 ± 0.3	1.014	0.050	0.498	0.003	0.081
	KS	2.15 ± 0.4	2.3 ± 0.9	2.2 ± 0.4	1.55	0.722	0.001	0.006	0.356
CI	N-KS	1.6 ± 0.2	1.3 ± 0.6	1.8 ± 0.4	1.662	0.000	0.077	0.336	0.014
	KS	1.9 ± 0.4	2.0 ± 05	2.2 ± 0.4	3.618	0.001*	0.004	0.000	0.315
CAL	N-KS	2.8 ± 1.6	2.9 ± 1.5	2.8 ± 1.8	1.148	0.863	0.133	0.622	0.091
	KS	3.8 ± 1.2	4.35 ± 0.7	4.7 ± 0.6	4.47	0.465	0.033	0.000	0.420

PLI: Plaque index, GI: Gingival index, CI: Calculus index, CAL: Clinical attachment loss.

**Table 3.** Correlation in clinical parameters with calculus index of all patients with ANOVA test.

Groups	CP	PSG	PLI		GI		CAL	
			r	P-value	r	P-value	r	P-value
GI	CI	N-KS	0.573	0.035	0.724	0.040	0.818	0.036
		KS	0.276	0.015	0.229	0.021	0.481	0.041
GII	CI	N-KS	0.602	0.007	0.811	0.011	0.516	0.013
		KS	0.335	0.001	0.298	0.000	0.169	0.022
GIII	CI	N-KS	0.246	0.023	0.447	0.036	0.691	0.024
		KS	0.899	0.001	0.399	0.003	0.188	0.001

G: Group, PLI: Plaque index, GI: Gingival index, CI: Calculus index, CAL: Clinical attachment loss.

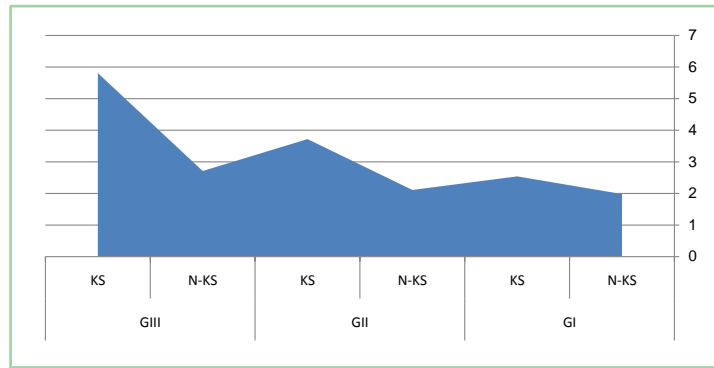
**Table 4** and **Figure 3** demonstrate the mean of salivary uric acid levels among the patients in the different groups (mg/dl) of the present study. The statistical analyses revealed statistically significant differences in the level of salivary uric acid in the comparison between kidney stones patients and non-kidney stones patients in group I and group III, whereas there were highly statistically significant in the comparison between kidney stones patients and non-kidney stones patients in group III.

The correlation between age and all clinical parameters were summarized in **Table 5**. There were statistically significant differences in the comparison between the age of patients and all clinical parameters except GI.

Regarding the correlation between the level of salivary uric acid and all clinical parameters, it is found to be statistically significant differences in the comparison between the level of salivary uric acid with PLI and GI whereas it was highly statistically significant in the comparison between the level of salivary uric acid with CI and CAL (**Table 6**).

#### 4. Discussion

Several studies showed the calcifications in the body (stones) with a decrease in the number of studies that tried to demonstrate the connection between these stones. These studies clarified that these stones have the same structure. Therefore, some of the studies considered their formation as metabolic disorders, and their components are identical in different organs [30] [31] [32]. In this retrospective study, the dental calculus formation was detected among most kidney stones patients more than non-kidney stones patients due to the kidneys' work in an important way to organize the levels of uric acid in serum [33]. Similar to the study results of Davidovich E. *et al.* where they demonstrated that the calcium, phosphate, uric acid, and magnesium components in saliva play an important role in the association between kidney stones formation and, dental calculus formation. Furthermore, they found there was a relationship between the distribution of mineral metabolism and calculus formation among kidney disease patients [34].



**Figure 3.** Salivary uric acid level. G: group, N-KS: non-Kidney stones, KS: Kidney stones.

**Table 4.** The mean of salivary uric acid level among patients in different groups (mg/dl).

Groups		Mean ± SD	ANOVA			
			F	P- value	F	P- value
Group I	N-KS	1.98 ± 0.43	0.615	0.051		
	KS	2.54 ± 0.67				
Group II	N-KS	2.11 ± 0.31	0.798	0.002	0.302	0.001
	KS	3.72 ± 0.70				
Group III	N-KS	2.71 ± 0.52	0.751	0.000		
	KS	5.81 ± 0.21				

G: group, SD: Standard deviation, N-KS: non-Kidney stones, KS: Kidney stones.

**Table 5.** The Correlation between Age and all parameters.

Correlations	Age	
	r	P-value
PLI	0.233	0.005*
GI	0.062	0.433
CI	0.03	0.003*
CAL	0.177	0.05*

PLI: Plaque index, GI: Gingival index, CI: Calculus index, CAL: Clinical attachment loss. \*statistically significant differences.

**Table 6.** The Correlation between the level of salivary uric acid and all parameters.

Correlations	level of salivary uric acid	
	r	P-value
PLI	0.714	0.004
GI	0.881	0.017
CI	0.136	0.000**
CAL	0.632	0.0001**

PLI: Plaque index, GI: Gingival index, CI: Calculus index, CAL: Clinical attachment loss. \*\*Highly statistically significant.



There was high plaque formation in the present study among kidney stones patients more than non-kidney stones patients, and dental calculus is dental plaque mineralization [18]. The result of the present study has supported this clarification that exhibited there was a correlation between the high value of PLI and an increase of calculus formation among kidney stones patients. Consequently, we evaluated the patients depending on the history of kidney stones, clinical examination of periodontal tissues and, assessment of calculus formation on the teeth surfaces with a uric acid level in saliva.

Results of the former study displayed that the prevalence of kidney stones is more among males (66%) than females and widespread within 31 - 40 years age group [35]. These results are appropriate with the objective of the present study that was done on 120 male Saudi patients within the age group (25 - 70) years, which included the age group (31 - 40) years. We explained to the patients the nature of calculus and, its impact on oral health and periodontal status moreover the possible correlation between calculus formation and the formation of kidney stones. According to previous studies, many researchers found significant links between kidney stones formation and accumulations of dental calculus on the teeth surfaces [34] [36]. Identical to the clinical findings in this study, we detected that there are significant correlations between kidney stones formation and dental calculus accumulations.

The current study and the study conducted by Brito *et al.* showed that GI and CAL were more in kidney stones patients group than non-kidney stones patients [37]. Consistent with the clinical findings of other studies revealed that periodontal destruction was more among kidney stones patients more than non-kidney stones patients [17] [38] [39] [40].

The higher mean values of GI, CI, and CAL among study group in the present study may be due to the higher mean values of PLI scores that recorded among kidney stones patients more than non-kidney stones patients in all study groups with statistical significance difference in all clinical parameters except GI among of kidney stones patients and CAL in kidney stones patients and non-kidney stones patients since dental plaque is the main etiological factor of periodontal diseases [41]. Xerostomia represents an oral complication of kidney stones disease and maybe predispose factors to gingival disease [42]. This is in agreement with the present study where the gingival disease was detected among all the kidney stones patients.

On the other hand, Uric acid is a major salivary antioxidant of healthy and diseased periodontal cases and there were many early studies comparing the salivary antioxidants levels among periodontitis patients and their levels in individuals with healthy periodontal tissues [8] [43]. Our results displayed the presence of a higher amount of salivary uric acid level in kidney stones patients compared to non-kidney stones patients. This result is supported by the results of other studies done by Hadi BA *et al.* (2011) and Xia Y *et al.* (2012) that displayed the levels of salivary uric acid in kidney stones patients were significantly higher than those of non-kidney stones patients [44] [45].

In the present study, there was an association between an increase of periodontal destruction and an increase in the level of salivary uric acid among kidney stones patients compared to non-kidney stones patients. Consequently, the present study demonstrated that there were highly significant differences in the dental calculus mean values among kidney stones patients than the non-kidney stones patients. This may be due to the presence of higher values of salivary uric acid level among kidney stones patients (mg/dl) compared to non-kidney stones patients in all study groups which corresponds to the results of other studies [46] [47]. Finally, many previous studies have tried to explain the relation between renal diseases in general, and the severity and type of periodontal diseases, but their findings were incompatible, that may be due to the massive debate in periodontal disease classification [48]-[53].

### **5. Strength and Limitations**

This study participates in the current efforts to explain the relationship between salivary uric acid levels and periodontal health among Kidney stones patients and non-Kidney stones patients. However, the cross-sectional nature of the study, self-reported medical conditions through medical history in the patient's case sheet, participants' consents and selection of study participants from the patients of a college of dentistry, King Khalid University, absence of female participants, and small sample size considered as limitations of the study.

### **6. Conclusion**

We studied the cases depending on the kidney stones' history, dental calculus and periodontal status evaluation and salivary uric acid measurement where there was a statistically significant difference in dental calculus formation among patients with kidney stones more than non-kidney stones patients. This correlation between an increase of dental calculus formation and kidney stones formation in the current study may be due to the minerals that form the kidney stones that may be accumulate in other areas of the body. This may be evidence that dental calculus can form a diagnostic indicator to help in the detection and diagnosis of kidney stones in case of recurrence of dental calculus formation. Consequently, the detection of a dental calculus during the clinical examination may be considered a predictor of kidney stones present, and this conclusion should be subjected to more studies.

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### **Conflicts of Interest**

The authors declare no conflicts of interest regarding the publication of this paper.

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